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AMENDMENTS TO THE DRAWINGS:

The attached annotated sheet of drawings includes changes to Figure 7. Further, a “replacement” sheet incorporating the proposed corrections is submitted herewith. In Figure 7, the larger roller previously labeled “6” has been re-labeled --6a--.

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REMARKS

Claims 1-20 are all the claims presently pending in the application. Claims 1-6 have been amended to more particularly define the invention. Claims 7-20 have been added to assure Applicant the degree of protection to which his invention entitles him.

It is noted that the claim amendments made herein or later are not made to distinguish the invention over the prior art or narrow the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein or later should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 1-6 stand rejected under 35 U.S.C. §112, second paragraph, as being as being indefinite. Claims 1, 3 and 5-6 stand rejected under 35 U.S.C. §102(b) as being anticipated by Stokely (U.S. Patent No. 3,204,428). Claim 2 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Stokely, in view of Olschewski, et al. (U.S. Patent No. 4,436,516). Claim 4 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Stokely.

These rejections are respectfully traversed in the following discussion.

I. THE CLAIMED INVENTION

An exemplary aspect of the invention, as recited in claim 1, provides a cross shaft including a trunnion, a roller bearing externally provided at the trunnion, and a recess formed at a distal end face of the trunnion, wherein a bottom region of the recess has a spherical shape and an opening region of the recess except the bottom region has a spherical shape different from the spherical shape of the bottom region.

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In another aspect of the invention, as recited in claim 10, is described a cross shaft including a trunnion, a roller bearing externally provided on the trunnion including rollers arranged in a plurality of rows in parallel in an axial direction of the trunnion, a plurality of bearing rolling faces corresponding to the plurality of rows of rollers provided on an outer peripheral face of the trunnion reduced in diameter from a root of the trunnion toward a distal end of the trunnion, and a recess formed at a distal end face of the trunnion, wherein the recess includes a bottom region having a spherical shape and an opening region having a tapered shape opening toward an opening end edge of the recess.

Yet another aspect of the invention, as recited in claim 18, provides a cross shaft including a trunnion, a roller bearing externally provided on the trunnion comprising rollers arranged in a plurality of rows in parallel in an axial direction of the trunnion, and a plurality of bearing rolling faces corresponding to the plurality of rows of rollers provided on an outer peripheral face of the trunnion reduced in diameter from a root of the trunnion toward a distal end of the trunnion, wherein a radial clearance between the rollers and the rolling faces is increased for each of the plurality or rows from the root of the trunnion toward the distal end of the trunnion and diameters of the rollers comprising the roller bearing are the same.

In conventional trunnion structures, there has been a tendency for the rollers to break down when the contact face pressure of the rollers at the distal end of the trunnion is increased at a time of torque transmission under high load. To avoid such a break down, it is known to arrange the rollers in a plurality of rows in an axial direction along the trunnion, where the diameters of the rollers in respective rows are made successively larger toward the

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root of the trunnion in order to substantially equalize the contact face pressure at the time of torque transmission. (See Application at page 1, lines 13-25)

However, the higher the load during torque transmission, the larger the differences must be made between the diameters of rollers in the respective rows. As such, since the radial clearances of the rollers with respect to the trunnion must be made larger, the rollers become liable to skew. (See Application at page 2, lines 1-8)

It has also been proposed to provide a recess substantially in the shape of a frustum of a cone at the distal end of the trunnion to reduce the bending rigidity of the trunnion. In this manner, the trunnion can be flexed at the time of torque transmission, thereby reducing deflection of bending stress to the root of the trunnion. (See Application at page 2, lines 10-16) However, there are concerns that when a large recess is formed, rigidity of the trunnion with respect to the applied load may be insufficient. (See Application at page 2, lines 18-22)

The claimed invention, on the other hand, provides a trunnion having a plurality of bearing rolling faces corresponding to the plurality of rows of rollers provided on an outer peripheral face of the trunnion successively reduced in diameter from a root of the trunnion toward a distal end of the trunnion, where the radial clearance is increased for each of the plurality or rows from the root of the trunnion to the distal end of the trunnion. By forming the rolling faces in this manner, it is possible to equally distribute the contact face pressure exerted on the rollers during torque transmission, while preventing the rollers from skewing. (See Application at page 7, lines 13-17)

The claimed invention also provides trunnion having a recess formed at a distal end face of the trunnion, wherein a bottom region of the recess comprises a spherical shape and an

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opening region of the recess except the bottom region comprises a spherical shape different from the spherical shape of the bottom region. These features enable the trunnion to be flexed in its entirety from the root of the trunnion. When flexed in such a manner, the rollers are evenly brought into contact with their respective rolling faces and, as such, the concentration of the contact face pressure to the edges of the rollers is restrained. In this manner, the exfoliation life and bending strength of the rolling faces of the trunnion can be enhanced. (See Application at page 10, lines 3-14)

II. THE 35 USC § 112, SECOND PARAGRAPH REJECTION

Claims 1-6 stand rejected under 35 U.S.C. §112, second paragraph. The claims have been amended, above, to overcome this rejection. Specifically, the informalities cited by the Examiner have been addressed.

In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw this rejection.

III. THE PRIOR ART REFERENCES

A. The Stokely Reference

The Examiner alleges that the invention of claims 1, 3, 5 and 6 are anticipated by Stokely. The Examiner also alleges that the invention of dependent claim 4 is unpatentable over Stokely. However, Applicant respectfully submits that the reference does not teach or suggest each and every element of the claimed invention.

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Stokely discloses a universal joint having a unique bearing assembly adapted to self-align the bearing cup with respect to the central axis of the trunnion. (See Stokely at column 2, lines 30-36)

However, Stokely does not disclose or suggest “a recess formed at a distal end face of the trunnion, wherein a bottom region of the recess comprises a spherical shape and an opening region of the recess except the bottom region comprises a spherical shape different from the spherical shape of the bottom region,” as recited in independent claim 1 (emphasis added). Independent claim 10 contains similar language.

Rather, Stokely teaches that “*the centering means comprises a female socket portion 40 having a semi-spherical configuration.*” (Stokely at column 4, lines 70-74) (emphasis added) (See also Stokely at Figures 2 and 4 and column 4, lines 72-74) According to Stokely, the entire recess at the end of the trunnion has a semi-spherical shape.

However, in the case where the recess is formed in a single spherical shape in its entirety from the bottom region to the opening of the recess, as in Stokely, the largest bending stress does not act on the root of the trunnion. Rather, bending stress is at its largest on the rolling faces opposite the recess, and thus, the trunnions become defective in strength. (See Application at page 10, lines 16-22)

The invention of claim 1, on the other hand, provides a recess having a spherical shape in the bottom region and the opening region having a different spherical shape. Similarly, as recited in claim 10, the opening region has a tapered shape opening toward an opening end edge of the recess. In either aspect of the claimed invention, only the bottom region of the recess has a spherical shape. As noted above, the shape of the recess, as recited

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in claims 1 and 10, allows the trunnion to be flexed in its entirety from the root of the trunnion and therefore enables the even distribution of the contact face pressure.

Clearly, Stokely does not teach or suggest this feature. With this feature, a trunnion can be flexed in its entirety from its root. As noted above, if the whole recess from the bottom region to the opening region is formed in a single spherical shape, maximum stress is concentrated in the rolling face where the recess is provided, not to the root of the trunnion. Therefore, the rigidity of such a trunnion becomes insufficient.

Further, the Examiner concedes that Stokely does not disclose or suggest a trunnion having “a plurality of bearing rolling faces corresponding to the plurality of rows of rollers provided on an outer peripheral face of the trunnion successively reduced in diameter from a root of the trunnion toward a distal end of the trunnion,” as recited in independent claims 10 and 17.

Therefore, Applicant submits that there are elements of the claimed invention that are not taught or suggest by Stokely. Therefore, the Examiner is respectfully requested to withdraw this rejection.

B. The Olschewski et al. Reference

The Examiner alleges that Stokely would have been combined with Olschewski et al. to form the invention of claim 2. However, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

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Olschewski et al. discloses a support means for trunnions including a bearing bushing having a sleeve section adapted to axially support the trunnion and a plurality of cylindrical rollers arranged in at least two side by side rows. (Olschewski et al. at Abstract)

Applicant respectfully submits that these references would not have been combined as alleged by the Examiner. Indeed, no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

In fact, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, contrary to the Examiner's allegations, neither of these references teaches or suggests their combination.

Therefore, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

Neither Stokely, nor Olschewski et al., nor any combination thereof, teaches or suggests that "*the trunnion is provided on an outer peripheral face thereof with a plurality of bearing rolling faces which are reduced in diameter from a root thereof toward a distal end thereof*," as recited in claim 2. (emphasis added) Independent claims 10 and 18 contain similar language.

The Examiner concedes that Stokely does not teach or suggest this feature. Rather, the Examiner attempts to rely on Figure 1 and column 3, lines 1-10 of Olschewski et al. to make up for the deficiencies of Stokely.

However, this feature is not taught or suggested Olschewski et al. In fact, nowhere do the cited figures or passages teach or suggest that the trunnion is provided on an outer

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peripheral face thereof with a plurality of bearing rolling faces which are reduced in diameter from a root thereof toward a distal end thereof.

Rather, Olschewski et al. discloses that “the inner race 25 of the row of cylindrical rollers 10 nearest the bottom section 9 of the bearing bushing 7 is of conical configuration and is slightly tapered radially outwardly toward the bottom section 9.” (Olschewski et al. at column 6, lines 23-27) However, “[t]he inner races 15 and 25 are located adjacent one another on the trunnion 6 without offset and are the same diameter.” (Olschewski et al. at column 6, lines 27-29) (emphasis added) In contrast, in the invention of dependent claim 2 and independent claims 10 and 17, the bearing rolling faces on the trunnion are reduced in diameter toward the distal end of the trunnion.

Olschewski et al. actually specifically teaches away from the claimed invention stating that when “the trunnion is tapered in steps towards its end in order to form inner races ... it has been found that the end of the trunnion experiences high bending stresses by reason of the fact that it is of relatively small diameter and also due to the high notch stress produced at the step or juncture between the inner races of the trunnion.” (Olschewski et al. at column 1, lines 25-34) As such, according to Olschewski et al., “[t]hese combined stresses produce material fatigue and failure of the trunnion.” (Olschewski et al. at column 1, lines 34-35)

Olschewski et al. goes on to teach that “[f]urthermore, a trunnion with stepped or offset inner races is rather difficult to and uneconomical to manufacture.” (Olschewski et al. at column 1, lines 36-38) Clearly, Olschewski et al. teaches away from the invention of dependent claim 2 and independent claims 10 and 18, in which the bearing rolling faces on the trunnion are reduced in diameter.

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Further, Olschewski et al. fails to make up for the deficiencies of Stokely described above, directed toward providing a recess at a distal end face of the trunnion including a bottom region of the recess having a spherical shape and an opening region of the recess having a spherical shape different from the bottom region, so that the trunnion can be flexed in its entirety from the root.

Thus, even assuming arguendo that Olschewski et al. may disclose a plurality of bearing faces which are reduced in diameter, as asserted by the Examiner, there is no teaching or suggestion in Olschewski et al. of a recess at a distal end face of the trunnion including a bottom region of the recess having a spherical shape and an opening region of the recess having a spherical shape different from the bottom region, so that the trunnion can be flexed in its entirety from the root, as recited in claim 2. Independent claim 10 contains similar language. Indeed, the cited reference does not even recognize the desirability or benefit of providing such a feature. Therefore, Olschewski et al. clearly does not make up for the deficiencies of Stokely.

In light of the above, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of claim 24. Therefore, the Examiner is respectfully requested to withdraw this rejection.

IV. FORMAL MATTERS & CONCLUSION

The Examiner has objected to the disclosure. Accordingly, the reference character cited by the Examiner has been corrected.

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The Office Action objects to the Figure 7. The attached Request for Approval of Drawing Corrections amends Figure 7 to designate the larger roller --6a--.

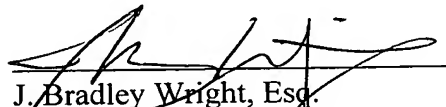
In view of the foregoing, Applicant submits that claims 1-20, all the claims presently pending in the application, are patentably distinct over the prior art of record and are allowable, and that the application is in condition for allowance. Such action would be appreciated.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned attorney at the local telephone number listed below to discuss any other changes deemed necessary for allowance in a telephonic or personal interview.

To the extent necessary, Applicant petitions for an extension of time under 37 CFR §1.136. The Commissioner is authorized to charge any deficiency in fees, including extension of time fees, or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 5/27/05


J. Bradley Wright, Esq.
Registration No. 47,188

Sean M. McGinn, Esq.
Registration No. 34,386

McGinn & Gibb, PLLC
8321 Old Courthouse Road, Suite 200
Vienna, VA 22182-3817
(703) 761-4100
Customer No. 21254

